

Solid Waste Management Using Geospatial Technology in Walled City Area of Jaipur

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Abstract—Solid Waste Management (SWM) is an important part of public health and environmental protection. Improper Management of solid waste leads to both economic and environmental suffering and instability. Management of solid waste includes control of generation, storage, collection, transport/transfer, processing and disposal of solid waste. All these factors of Solid Waste Management are having both spatial and non-spatial units. This paper will demonstrate the use of GIS in areas related to SWM, to increase the efficiency of system, reduce cost, workload and manpower, save time, and its use as a decision support system. This paper deals with use of geographical information systems (GIS) for waste collection, transportation and dumping, which allows driving routes to be optimized for minimum fuel consumption and minimum length. A geographic information system (GIS) is used to find out the minimum cost for the collection and transportation of municipal solid waste. In This study used a GIS to model in existing and proposed collection patterns using Esri ArcGIS Network Analyst software. The software was used to conclude best and economical routes for small collection of groups and tracing the workflow and best practices for future analysis throughout the city.

Keywords: Solid Waste Management, Remote Sensing, Geographic Information System, Route Optimization.

1. INTRODUCTION

Solid waste management (SWM) is an integral part of the public health and environmental control. Solid waste generated right from the beginning of humanity and natural and food waste. Problems were less in extent earlier, however, with rapid urbanization, and development of technologies – e.g. packing, the problems of solid waste become more complex as more and more solid waste is generated [1]. With the passage of time and continuous urbanization the situation gets more and get more and more critical.

Solid waste management issue is on a higher note in the highly densified areas. Due to the increase in public awareness about solid waste has resulted in large increase in the priority given to waste management by the government [2]. If solid waste managed improperly than it leads uncontrolled throwing of the waste and badly maintained waste results in growth of diseases as well as increase the presence of unwanted species

such as rats and mosquitoes and bad odor created around the garbage area leading to unaesthetic conditions which may further leads to decrease the market value of the area [3].

Collection and transportation of solid waste often accounts for important percentage of the total waste management budget containing labor costs [4]. The figure can reach over 70%, relying on geographical location and fuel price [1, 2]. For each selected product and waste stream, a life cycle analysis was performed with an emphasis on waste transport and related vehicle emissions [5]. They considered different collection schemes, distances to treatment or disposal sites, means of transportation, and vehicle loads [6].

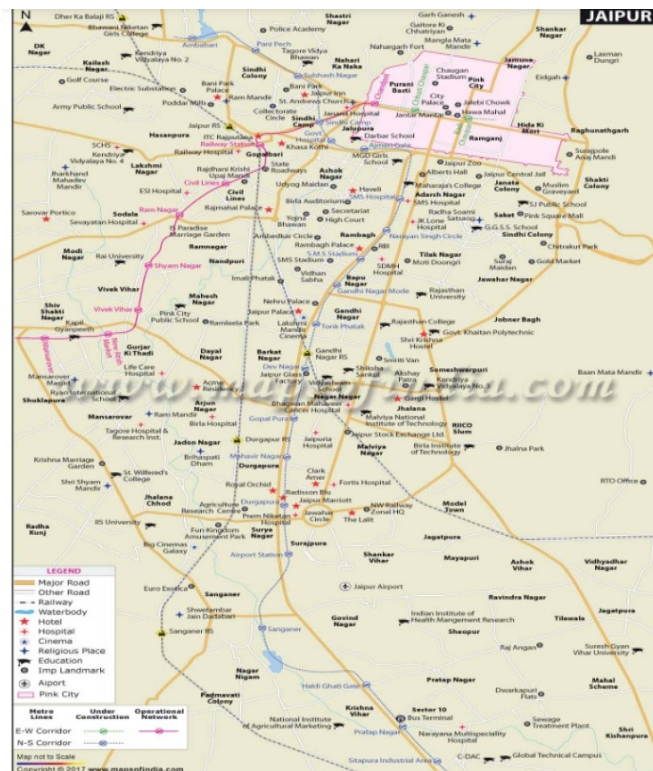


Fig. 1 Jaipur City Map (Source: Map my India)

A large part of a city waste budget goes towards fuel, waste collection vehicles maintenance. To reduce overall costs, the Jaipur city, take the help of GIS technology. The Jaipur city was not sure how to build better travel routes to increase efficiency, and it is a complicated problem having many factors, considering the position of waste bins, operational hours, collection details, driving habits, type of vehicle etc. The Jaipur city wanted to know the best proposal and structure optimize waste collection routing for the city using GIS.

This project aimed to create optimized routes for wastes vehicles in a selected area of the Jaipur city. GIS was used to calculate the most efficient routes for the waste collecting vehicles by considering reducing travel time and overall travel distance. The initial goal of this project was to minimize overall travel cost for collecting and transporting of municipal solid waste from the bins to destination. In this method reduce the overall length amount to driven collect and transport residential waste container bins as well as reduce the overall time taken by vehicle to collect and transport residential waste container bins.

2. METHODOLOGY

Study the data collection about the present waste management collection and transportation system in Jaipur city. City information is available in four different mediums which will be brought together in one platform where they can be linked together and correlated. These four mediums are maps containing spatial information, spatial data about location of waste bins and building, attribute information about spatial data and other information source through interview with municipal officials to provide information about working patterns, and a questionnaire was prepared for the public to know their behavior regarding waste management and get their opinion in this regard.

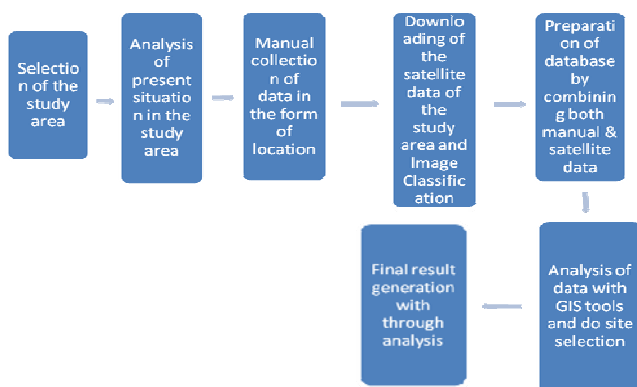


Fig. 2 Methodology Flow Chart

Analyzed problems as well as limitations and restrictions in city waste management system. Discussion and critical analysis of SWM models presented in literature studies. Design and implementation of GIS model, for route planning.

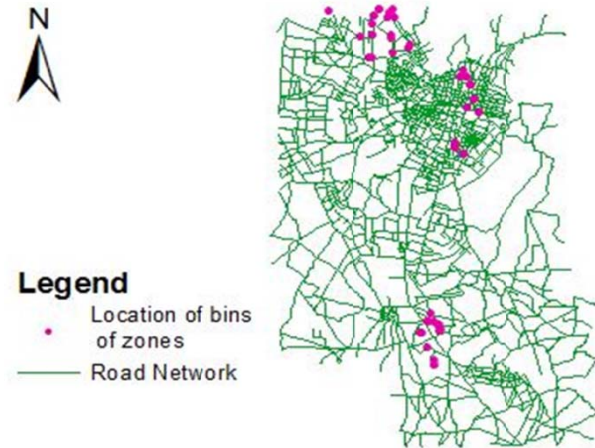


Fig. 3 Plotted Coordinates of Waste Bins

2.1 Experimental Details

GIS tools such as network analyst are used to carry out complex calculations to resolve vehicle routing problem. The network analyst of GIS can be used to perform many operations over a network. It can be used to assess associated edges and decides fleet routing, travel trajectory, closest facility, service area, and allocation of location [2, 6]. In the application for route accession, network dataset edges represent the road network being traversed. Network Analyst facilitates the user to dynamically model trusted network situations [6]. These situations can contain speed limit, traffic volume at different times of the day, one-way streets, turnabout restrictions, obstacles, road conditions, and drawbacks. Network analyst key functions included to establish a network with current GIS data, establish existing route network of collection in the area, produce travel network cost matrix, define optimal facility positions using location allocation and determine shortest routes to travel for collection vehicles.

The Vehicle Routing Problem (VRP) is used to estimates the least cost path for vehicles to improve the efficiency and avail overall operating cost [6]. The VRP can be used to assign capacity values to each route and this will control the instance, volume, weight, or quantity of a vehicle for each route. The VRP can be used to delineates work territories for given routes and is used to constrain routes to improving only those orders that fall within or near the certified area [6]. VRP solver is a suggestive element to consider whenever advancing a waste collection route raise plan [5, 6].

3. RESULT AND DISCUSSION

GIS tool used to find out least cost and distance route for collection of waste from bins located in different zones of Jaipur city. In this study four different zones were selected for analysis of route. Out of 4 zones one is selected from centre

city also called walled city area, one is selected in the middle of city and two selected from outer part of the city.

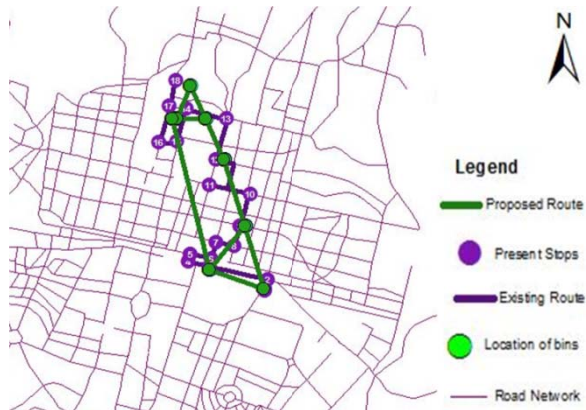


Fig. 4: Proposed Route of Hawa Mahal Zone

Result of this project tried to find the difference between proposed and existing route length of different zones. Hawa Mahal Zone was having existing route length 20476.24 meters for waste collection and the proposed route length for the same waster location is found to be 15088.33 meters.



Fig. 5 Proposed Route of Motidungri Zone

Another zone (Motidungri) is located 3-4 km away from walled city area. It was having route length of 2165.16 meters for waste collection whereas proposed route length is founded to be 1972.49 meters. The difference between proposed and existing route is only 192 meters but if it is consider for a month than it may reduce 3 days fuel consumption.

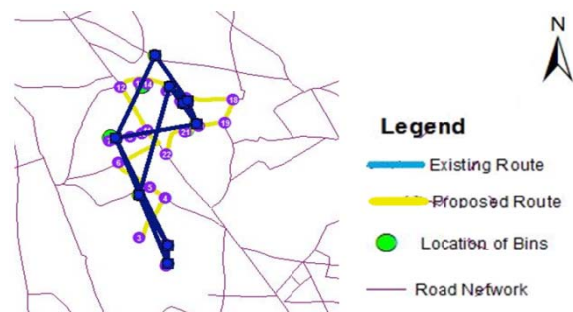


Fig. 6 Proposed Route of Sanganer Zone

The third zone (Sanganer) is located in the southern part of Jaipur city. It is located in the out skirt of the city. Therefore less dense built is there to collect waste from this zone. The existing route is estimated to 9869.2 meters, whereas proposed route estimated using GIS is 7681.7 meters. The difference between existing and proposed route is 2187.5 meters, which is a huge difference between current and proposed route.

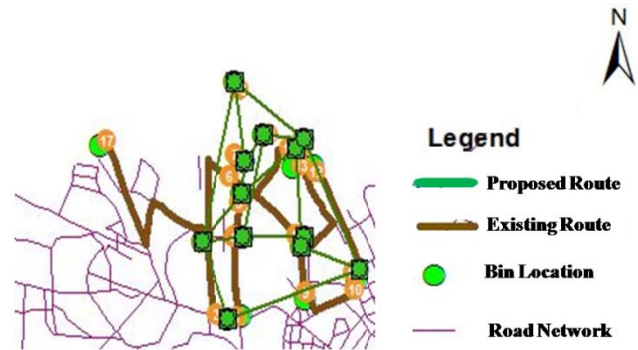


Fig. 7 Proposed Route of Vidhyadhar Nagar Zone

Vidhyadhar Nagar zone, which is located in north western part of city and it is also in the out skirt of the city. This zone was having existing route length to be 20347.22 meters and the proposed route length is founded to be 17803.31 meters. The difference found between existing route and proposed route is 2543.91meters. This zone is located in outer part of city, therefore less dense urban and covering large area.

4. CONCLUSION

The objective of this research was to find the optimize routes of solid waste collection vehicles in all those four zones which have selected and generate the decent results by minimizing the route length upto 5 kilometers in all the zones. The results of this study demonstrated the relevance of optimizing route for waste collection vehicle to reduce distance and time. Thus, the difference which comes out between the existing length and the proposed length gives us the area which have been reduced by this project and thus making the system more economical. The change which is calculated are differentiated by different zones i.e. zone -1 (Sanganer) has 2187.5 meters, Zone -2 (Motidungri) has 192.67 meters, Zone -3 (Vidhyadhar Nagar) has 2543.91 meters, zone -4 (Hawa Mahal) has 5387.91 meters. This change helps us in making system more efficient and controlling the expenditure of the country used in solid waste management.

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